The Future Course and Application of Big Data Solutions in the Support of Decision-making in Businesses

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Abstract

The amount of data is continuously rising. It is especially the case of unstructured data that can contain a substantial information value if a business is able to capture and process it. For this reason, new technologies, methods and procedures emerged that are collectively noted as Big Data. A Big Data solution enables businesses to examine the shortcomings of conventional business information systems, especially in relation to the ability to process large volumes of various data in relevant time. The continual advances in the field of information-communication technologies are making the technical solutions still more and more accessible for the common users. This positively affects the growth in the generation of an abundance of various data. However, it also brings a higher level of efficiency and the automation of the processes on all levels of personal, social, and business environment. The data can be considered as another production factor that becomes an essential part of the decision-making processes. Regarding the complex solutions that are already coming (such as Industry 4.0, Smart City, the Internet of Things, etc.), businesses need to choose a suitable analytical platform for the sustainable processing of large amounts of data in the future. The article presents an analytical perspective of the authors regarding the course and application of Big Data solutions connected to the decision-making in businesses. To elaborate the analysis and draw conclusions, mostly secondary sources of data and case studies were used.

Keywords: Management, Big Data, Business, Decision-making, Technology.

Introduction

At present, each area of a business's operation needs a considerable amount of data to function properly, while the data is being processed and utilized on a daily basis. Technological advancements have caused an exponential growth of various types and forms of data. Conventional business information systems are no longer able to process it in connection to its amount and the required time. Due to the increasing amount of the data and its value, Big Data solutions emerged. These contain a multidimensional framework for the generation of values via the growing amount of data. Their impact contributed to the variety of all the spheres of life, ranging from businesses, cities, transport, e-commerce, health care, environmental sciences, to security forces, and intelligent homes. Big Data can be considered to be a shift in the paradigm of perception of various ways of understanding and studying the whole world. Big Data serves multiple purposes including not only the gathering of data but also its subsequent utilization for analyses. The result is represented by the information extracted, based on which it is possible to improve the managerial processes in businesses on all the managerial levels.

Literature Review

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The development in the field of technology created the conditions for the expansion of the digital era. Technologies have become a necessary part of people's lives. (Lendel, Varmus, 2010) Businesses are no exception. Nowadays, they are working with a huge amount of data that grows exponentially and requires more and more storage, while being generated in various formats. (Cisco, 2021b) Around 2.5×10^{30} bytes of data are generated daily. (Cisco, 2021b) According to an online statistic, the data mostly comes from the use of the Internet, sharing of the content on social networks, sending e-mails, etc. The amount of data rises each second. (Internet Live Stats, 2021) For example, 200 billion e-mails are sent on average every day. Conventional business information systems are not able to work with such a large amount of various data or to deliver the necessary information to the managers on time. Due to the growing amount of data, mainly of the unstructured type, and its value, Big Data emerged as the technology for analysing and processing large volumes of data. The interest of businesses in this technology is rising as well.

The term Big Data characterizes a large volume of data or information coming from heterogenous sources, such as pictures, texts, sensors, webpages, technological devices, or people. (Cisco, 2021b) These can also be the structured or semi-structured data from B2B and B2C processes and interactions. (Elia et. al, 2020) The gathered data can be divided into two basic categories, the structured and the unstructured data. The structured data is generated by the applications and the unstructured data (sound, video, webpages, social media, mobile data, text, tweets, etc.) is generated by a multitude of sources. (Sheng et. al, 2017, Soviar et. al, 2017, Lendel et. al, 2014) Both forms of data need to be processed into a common format that can be analysed. The transformation of the data into a common format is a valuable way of combining various information. According to the authors of a particular scientific work (Elia et. al, 2020, Pollák et. al, 2019, Holubcik et. al, 2018) Big Data represents a new wave of business opportunities, competitiveness, and technological innovations. They affect multiple sectors, from the health care system, online shopping, finance, to public security. (Elia et. al, 2020, Novak et. al, 2020) Big Data can also be defined as a production factor characteristic for its large volume, high speed, and variety. A part of this production factor is represented by specific technologies and analytical methods enabling the transformation of the generated data into value. (Šulyová, Vodák, 2020, De Mauro et. al, 2016, Holubcik, Falat, 2016)

Big Data can be described via three factors: volume, speed, and variety. (Cisco, 2021b) Several authors studied the importance of individual factors. For example, in relation to the variety of the data according to the sources available, Biga Data enables processing various data formats in a reliable way. (Habeeb et. al, 2019, Janeja et. al, 2014) Based on the results of other authors, the initial model of 3Vs was modified and extended. Thus, other two factors should be taken into account too, namely the veracity and value. For businesses using Big Data, only reliable data is significant. Other substantial elements are the management, quality control, and the accuracy of data. With the data gathered, it is also necessary to focus on its value and advantages for the particular business or organization. (Elia et. al, 2020) The development of the model is not final yet. According to another study (Amanullah et. al, 2020), the Big Data solutions and the processes connected to them must be innovated to ensure that valuable information will be extracted from the various data available. Big Data can currently be characterized by six fundamental elements. These are the volume, velocity, variety, veracity, variability, and value of the data. (Amanullah et. al, 2020) The described characteristics are depicted in the following figure (Figure 1).

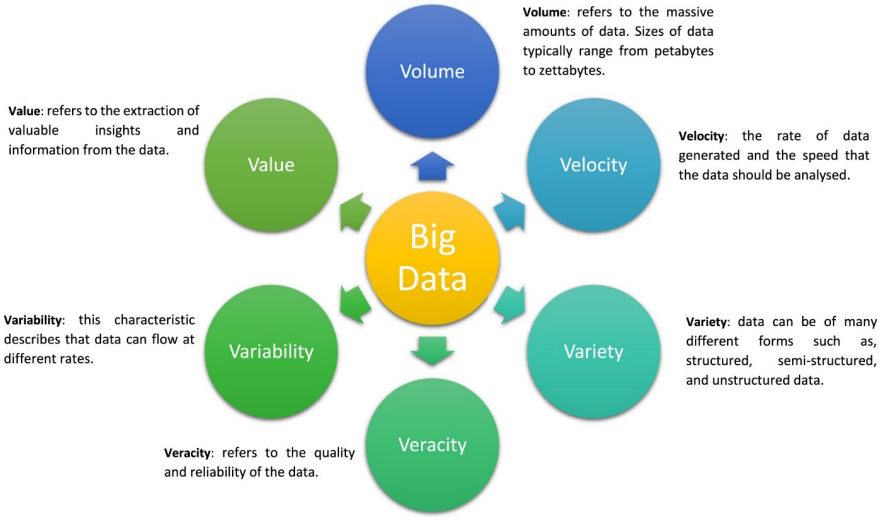

Figure 1. 6 Vs model of Big Data (Amanullah et al, 2020)

Development and the future course of Big Data solutions in businesses

Regarding the characterization of Big Data via the model of 6Vs, it can be assumed that new solutions will need to be developed for efficient work with the data, especially of the unstructured type, that is important for a business but difficult to process. (Ekambaram et. al, 2018) The development in the field of Big Data is constant. The changes the businesses should take into account include (Olsson, Bull-Berg, 2015):

- increase in the volume of data, including the data from the Internet and the data from sensors,
- increase in the intervention of businesses on the Internet, focusing on sales/purchases of goods and services,
- intensification of the whole marketing on the level of a particular consumer,
- increase in the pressure on disclosing data,
- increase in the informatization of businesses,
- access to analytical platforms and data storages at lower costs.

In relation to the dynamics of the environment in which businesses want to be successful, the interest in Big Data rises, which can be observed in various areas (monitoring of the weather, energy industry, security sector, road transport, health care, tourism, banking, education, etc.). (Line et. al, 2020, Dixon, 2019, Juneja, Das, 2019, Nguyen, 2018, Liu et. al, 2017, Hu, 2016, Rahman et. al, 2016, Imawan, Kwon, 2015, Cillik, Novak, 2008, Novak, 2006) Businesses have started to perceive Big Data as their asset using which they can acquire valuable information. Due to Big Data solutions, businesses will be able to affect multiple aspects, ranging from processes to customers. An increasing interest in Big Data solutions is captured in Figure 2.

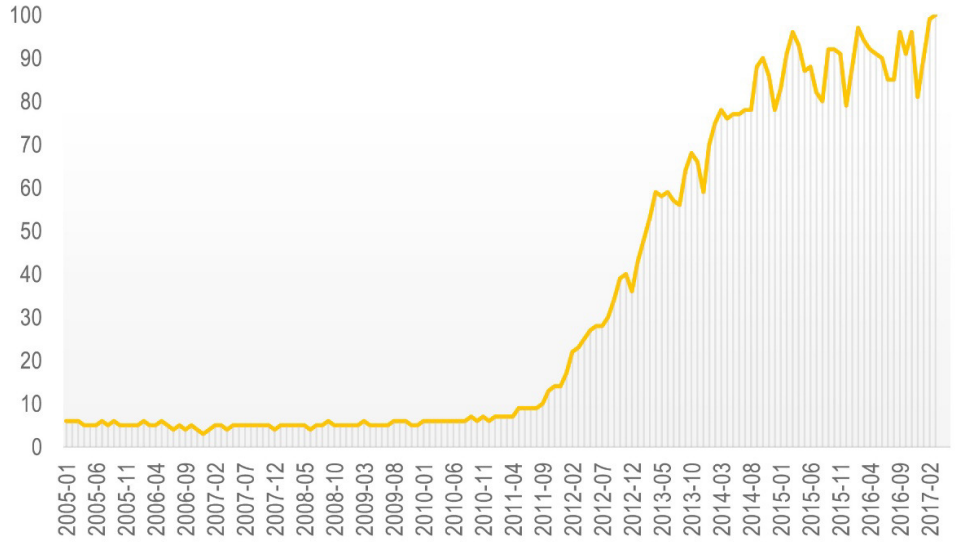

Figure 2. Searching the term Big Data in the Google searching engine (Sheng et. al, 2017)

An increased utilization of the technologies for analysing large volumes of data was also identified by the Google Trend tool, starting in 2013. The year 2016 can be considered a significant year when these technologies started to be used considerably more. (Google Trends, 2021) This finding is shown in Figure 3.

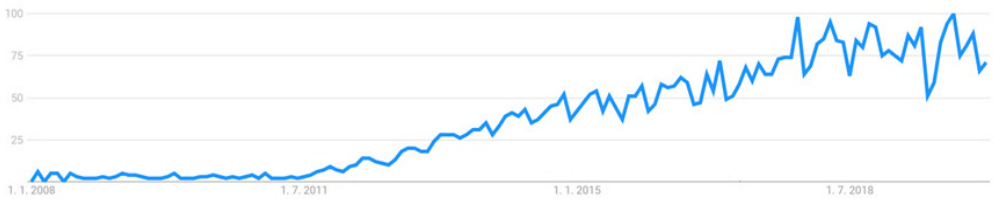

Figure 3. The course of using Big Data (Google Trend, 2020)

The development in the area of Big Data is also connected to the technologies that must be improved constantly due to the fundamental characteristics of data (especially its exponential growth). During the past several years, platforms and tools were created to process data that are more efficient than the previous ones. It is assumed that the future trend can be an intense utilization of in-memory databases systems. With the exponential growth, the demands on the technology's flexibility will rise as well. (Sheng et. al, 2017, Ferenc et. al, 2017)

Trends in the application of Big Data solutions in connection to decision-making in businesses

Big Data can be used in various industries. Substantial applications of Big Data solutions, based on the sources available, include the areas such as Industry 4.0 and human resources management. Big Data can be used to process the requirements within the Industry 4.0 concept as well as on the identification of problems in processes or even on performing predictive maintenance. Since the performance of machines is crucial, Big Data can be used to predict a failure in advance so the competent persons can decide on the corresponding changes in the ongoing processes (maintenance, stopping the production, etc.) Within the Industry 4.0 concept, Big Data solutions can positively affect the following aspects of the processes being performed: (Sahal et. al, 2020)

- increasing flexibility,
- making the decision-making more complex,
- optimizing the production, and so on.

In human resources management, Big Data can play a crucial role too. For human resources managers, Big Data can facilitate decision-making while also saving time. Big Data can be applied to categorize potential candidates applying for a specific position. This process can be performed using the data from social networks and employee applications. Since the job interview and the selection from the candidates belong to strenuous personalists' tasks, Big Data solutions can increase the probability of selecting the right person for the job. (Hamilton, Sodeman, 2020, Daňková, Droppa, 2015)

Regarding the development of new technologies and the increase in the volume of data, the trends in the field of Big Data include security, the necessity of gathering data as well as the current challenges and predictions.

According to the prediction from the NCTA study, in 2020 there ought to have been 50.1 billion IoT (Internet of Things) devices, and this number should reach 75 billion in 2025. (Amanullah et. al, 2020, Sarang, 2018) With the increasing number of devices, the exponential growth of generating data will continue too. There will also be more frequent incidents (attacks) aimed at stealing the data. (Sarang, 2018, Wong, 2014, Kubina, Lendel, 2012) According to another study (Amanullah et. al, 2020), the current tools and techniques being used by organizations to detect the incidents are not sufficient and this is being caused by Big Data characteristics (velocity, volume, variety, and veracity of data). In addition, the data related to security need to be processed in the shortest time possible so that the attack attempts can be identified and prevented. One of the solutions to this problem is using Big Data as it enables to cope with the challenges related to the speed, volume of data, its variety as well as reliability. The technological level of a Big Data solution ensures a secure transfer of data via ciphered methods that are focused on discreetness, completeness, accessibility, verification, and access management. (Amanullah et. al, 2020)

Big Data solutions provide new methods and techniques connected to data analysis for businesses in relation to their decision-making processes. These make decision-making easier and also enable businesses to implement innovations. (Jabbour et. al, 2020, Yang, Zang, 2017, Hittmár et. al, 2015) In the literature review, it was revealed that businesses should focus their attention on gathering structured and unstructured data from various sources to be able to better understand the preferences or needs of the consumers or identify the opportunities and threats. For this purpose, data on investments, the efficiency of processes, and the customers can be used. The data on the customers can be obtained from their previous purchases, social networks and other web pages. Due to the data gathered, businesses can save time and launch new products that are the results of obtained and applied information value extracted from the data available. The application of Big Data is limited in some industries because of the existing barriers of various nature. For example, in public administration, such application is very restricted. Based on a particular study (Guenduez et. al, 2020) focused on the opinions of managers from the public administration, it can be stated that the perception of Big Data by these managers is not unified. There are many differing opinions, such as the statement that Big Data represent a risk of breaching the privacy of citizens, being fully opposite to the statement that Big Data represents great potential. (Guenduez et. al, 2020)

One of the technological trends with a significant impact in relation to the Big Data is the Internet of Things (IoT) concept. IoT offers an opportunity to gather large volumes of data. These volumes need to be analysed so that patterns in the behaviour can be identified and the predictions can be created. (Holom et. al, 2020) Regarding the future application of Big Data in the decision-making, the following factors need to be considered according to: (Talend, 2021, Khvoynitskaya, 2020, Ahmed, 2020, Pickell, 2019, Straková et. al, 2017, Madzík et. al, 2017)

- the volume of data will be continuously rising, and the data will be stored in the cloud,
- by 2025 the volume of data will have reached 175 zettabytes,
- the demand for data will rise,
- the machine learning will advance,
- the issue of data protection will be stressed,
- the investment in the technologies for analysing large volumes of data will rise,
- Big Data solutions will be more accessible,
- providers of databases as services will offer the analysis of Big Data,
- Big Data analytics will become a part of the Business intelligence software,
- the process of cleaning the data will be automated.

The cases of implementing Big Data solutions in businesses

Metropolitan transit system in San Diego – The company was dealing with an issue with the architecture for planning and sharing the data in real time since it was required to provide accurate arrivals and departures of buses and trains. To create a solution for the transport in a large scale, Big Data was applied in cooperation with Cisco and Davra Networks. The solution provided the data for the key operations ranging from diagnostics, maintenance, to security monitoring, and improvement of the drivers' experience. (Cisco, 2021a)

Amazon's anticipatory shipping – They work with the data such as the history of orders, product searching, or the shopping basket history. Based on this data, they are able to predict when a customer will do the purchase again. Using this prediction, the order can be shipped to the closest centre before the customer actually places it. (Banker, 2014) The company benefits mainly from knowing the customers' needs, more accurate understanding of their preferences and behaviour via processing various data from the customers system.

The Ford Motor Company – They use the data on millions of customers. This is especially the data about the vehicles on the roads being captured by the sensors and the remote software. Based on the information obtained, the company innovates its products and improves the vehicles' design. (Banker, 2014) The benefit can be seen in the identification of the customers' needs as well as in the summarization of information serving as a tool for supporting the implementation of innovations.

Raytheon Corp. – This is a manufacturing company that developed intelligent factories using Big Data to process the data from various sources. These include the sensors, Internet transactions, digital records, or CAD models with the aim of controlling multiple elements in the production. (Tiwari et. al, 2016) The company benefits from capturing, storing and processing a large volume of various data which enables them to detect the deviations quickly.

General Electric – The company uses large volumes of various data to efficiently create service strategies via monitoring the data of the products such as locomotives, gas turbines, medical display units, or sensors. This way, the company ensures their efficient operation. (Tiwari et. al, 2016)

Schmitz Cargobull – A German company focused on producing bodyworks and trailers. The primary purpose for the data processing is the tracking of the route, temperature, cargo's weight, and trailers' maintenance to minimize the failures in their use. (Tiwari et. al, 2016) The company benefits from the identification of the vehicles' behaviour, monitoring of the performance, and from ensuring the products' functionality.

Toyota Motor Corporation – The company started using Big Data in 2016 to improve its data management possibilities. Connecting the automotive platform to the data gathering enables to create new products, such as adding safety elements into the vehicles, creation of a service with traffic information, or for getting feedback for the vehicles' design. (Tiwari et. al, 2016)

Netflix – The company outmatched a lot of its media competitors around the world, while its success is attributed to the Big Data analysis. Netflix gathers data from 151 million subscribers and applies the models of data analysis to examine the customers' behaviour. Based on the data obtained on the customers' preferences it recommends them films and series. (Dixon, 2019) According to the company, a part of its success is based on the data on the customers' interactions. (Sedeh, 2019) Netflix is known for its high degree of maintaining its customers. In comparison with its competitors, it is more successful in the identification of what the audience wants and in the subsequent use of such findings.

All the cases of use imply that the companies realize the need for timely information of high quality. The companies admitted that they should base their decisions on the data obtained and analysed. This way they will be able to improve the design of processes as well as make them more efficient. Companies that invested effort and funds into the technologies for analysing large volumes of data can achieve a competitive advantage and an overall improvement in their performance.

They are also able to adapt to the emerging changes much faster. Therefore, the companies should continue in effectively using the obtained data and its potential.

Materials and Methods

To sufficiently understand the topic, it was necessary to study foreign and domestic literature focusing on the issues of Big Data and its analysis. The pieces of information needed for the research presented in this article were obtained from secondary sources. These included specialized publications and Internet sources. During the phases of obtaining and processing information, and the design of the recommendations for the support of businesses' managers decision-making, the following methods were applied:

- market analysis,
- analysis of documents – the selection of relevant foreign and domestic publications and Internet sources pertaining to the studied topic,
- case study analysis – used in combination with the analysis of documents,
- comparative method – comparison of information from the analysed documents and studies,
- synthesis of findings – connecting and sorting findings from the information available,
- statistical evaluation – processing the information from documents,
- induction, deduction – drawing conclusions and designing recommendations for the support of decision-making,
- creative method – applied during the design of recommendations for the decision-making support.

Results

Based on the findings revealed during the analysis of the topic, an intensified need for performing processes connected to capturing, storing, and processing various data can be predicted. Businesses should fully realize the value and importance of information for decision-making, but not of any information. Decision-making requires relevant, timely, accurate, complete, and understandable information. Such information facilitates the process of decision-making, broadens the managers' knowledge, and increases the flexibility and efficiency of strategic decisions. Regarding the volume and structure of the data being generated, the conventional managerial information systems are not able to process them efficiently in relation to time or costs. Therefore, it is appropriate to implement a Big Data solution in businesses that will enable them to analyse almost all the data sources. Using the data available in combination with technologies for analysing large volumes of data, businesses are able to design the processes better as well as to make the decision-making process more efficient. The importance of decision-making skills should not be underestimated either. Managers make decisions every day and the impact of these decisions on businesses is substantial. Without correct and timely decisions, businesses could not improve the processes, satisfy their customers' needs, create new products, hire new employees, or perform the processes of change needed for them to advance.

The managers should also realize that the business's performance is based on the right organizational decisions. It can be stated that the achievement of better results in a business is the result of high quality of decision-making, the identification of bottlenecks, improvement, automation of communication, or in the identification of opportunities. The value of Big Data for the managerial decision-making lies in the fact that it enables to make decisions based on accurate information obtained from the analysis of a large volume of various data. However, correct decisions do not only require the information to be available. Appropriate management of the information is important as well. Businesses need to know which decisions based on the data they shall actually make, and which are not favourable in the current dynamic environment. Since the managers' decisions are conditioned by the relevance and availability of information, besides the structured data, managers should also use the unstructured data in connection with Big Data solutions. This type of data is being generated the fastest and it has the greatest relevance for decision-making support. The managers should use the data from social networks, data generated by mobile devices or sensors, the data from the Internet, etc. The utilization of technologies for analysing large volumes of data brings many advantages for the business. They give the managers clearly processed results, e.g., in the form of graphical reports that show the course of the customers' preferences, processes' performance, and others. Based on processing the data gathered using the set criteria, variants and their impacts, the managers could identify the best variant of solution for the decision-making task. Using Big Data gives the managers the opportunity to create a competitive advantage for their businesses. This advantage does not have to be related only to the data itself. It can be perceived as a fast acquisition of knowledge based on the obtained data. The results of studies used in the analysis show that the businesses' investments in Big Data solutions, if planned and focused on the issues they are supposed to cope with, actually do pay off.

The Big Data solutions have not reached their maximal potential yet, they are still developing. New possibilities of their application for the achievement of the businesses' goals are constantly being presented. Big Data solutions have become a popular, frequently applied choice among business information systems. The demand for this form of information system indicates that businesses have already started to deal with this topic intensively. A competitive advantage can be achieved

by those that are fast enough in utilizing the benefits of the information obtained. If neglecting the topic of Big Data, a business might not be able to cope with all the changes emerging in the dynamic, constantly developing markets. Also, when Big Data solutions become accessible on a user level (publicly), it will be an inevitable part of the business's market sustainability to have them implemented.

At present, Big Data represent a promising area for the generation of values. However, smaller businesses do not have to have a high number of customers, or devices generating such a large volume of data the business could benefit from. They do not need to generate their own data; they can use the databases available. In the future, it can be predicted that Big Data solutions will be applied in areas that require various, constantly topical information for decision-making. For example, Industry 4.0, health care, Smart City concept, and so on. For businesses to be successful, they need fast access to topical information that is being gathered at one place so that it can be used for performing further analyses. Therefore, the managers of large businesses should utilize the possibilities of Big Data solutions. There are several technological solutions available for businesses. An example of a solution that the managers could consider applying to support their decision-making processes is the one created by Oracle. (Oracle, 2021a, Oracle, 2021b) The benefits from implementing the solution from Oracle, or another supplier, include the following points:

- acquiring the ability to process various data,
- analysing the data in a protected and simple way,
- access to new technologies,
- integration with the business's information system,
- ensuring continuity in the decision-making processes,
- access to support services,
- faster manipulation with the data.

Business should invest in the technologies that are nowadays being developed very fast. But not only in them. They should also consider investing in people, especially those with the authority of making decisions. These need to know how to utilize the data gathered, manipulate them in a rational way and base their decisions on them that will help the business become more productive. This way, businesses can achieve a competitive advantage that is not only in finding out something new but also in how the information obtained is used and what it brings.

Based on the findings obtained, it is possible to illustrate the importance of Big Data in the future, using specific examples. In the Industry 4.0 area, a business will get accurate information on the state of production to make production processes more efficient. The authorized persons will be able to make decisions on the corresponding steps (maintenance, stopping the activity, etc.), which will prevent a failure in advance, ensuring a continuous operation. When utilizing Big Data to monitor the trends in purchasing behaviour, businesses will be able to better understand the customers' behaviour via the history of their orders. An example of this is the Netflix company, which attributes its success to the utilization of Big Data. This company realized the importance of data and focused on specific areas that should be solved using it. Their goal was to acquire as much accurate information about the customers and preferences as possible. Due to the application of a Big Data solution, the company was able to identify what the subscribers are interested in, the exact date when they were watching a specific title, a device they used, the titles they watched multiple times, as well as their searching history. Based on this information, the managers were able to make decisions on how to create recommendations of films and series tailored to the customers' preferences and how to ensure interest in the titles. Each decision was supported by accurate data gathered. For example, to ensure the interest in a specific series, several versions of the trailer were created regarding the findings about the customers. In the case when a customer mostly watched series focusing on women, a trailer presenting female characters was distributed to him/her. This example also points out the advantages of using Big Data to automate analyses and support decisions to approach a customer at the right time. (Sedeh, 2019, Varmus et. al, 2014) Other advantages the company can get from the application of a Big Data solution include:

- the ability of planning the recommendations of new series in a more detailed way,
- increase in the company's performance,
- increase in the revenues,
- building positive reputation based on the customers' satisfaction and their loyalty via the selected strategy,
- acquiring competitive advantage, and so on.

The company was able to perform thought-out decisions that ensured continuous exponential growth of the annual revenues. (Sedeh, 2019, Vodák et. al, 2017)

Conclusion

At present, almost every business field requires a lot of data for its problem-free operation, and this volume of data cannot be handled by conventional information systems. Big Data solutions react to the dynamic situation and offer a

multidimensional framework for the generation of values via data. For larger businesses and those generating or processing large volumes of various data, Big Data solutions represent an opportunity to gather and process data with a high information value. This enables managers to make better decisions based on valuable information. Businesses benefit from such decisions via more efficient processes, reduction of costs, and achievement of competitive advantage. To gain the expected results, businesses and managers need to understand the topic, identified the issues they want to solve, and then plan the implementation of a Big Data solution, which includes training the employees to work with it. Such steps will help the business overcome potential barriers and problems that can occur during the implementation of a Big Data solution within the business's information system.

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